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TITLE: ANALYSIS OF URBAN DATABASES WITH RESPECT TO MESOSCALE MODELING REQUIREMENTS

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1. INTRODUCTION

A number of different parameterization schemes are used in mesoscale models to approximate the effects of the urban canopy on the meteorological flow field. At a minimum, urban landuse information is needed to help prescribe roughness and surface energy balance parameters. More complex urban canopy parameterizations (e.g., Sorbjan and Uliasz, 1982; Brown and Williams, 1998; Ca et al., 1999) require morphological information cross-correlated with landuse, for example, average building height, plan area density, and building area density vs. height as a function of landuse. In this paper, we look at two primary issues: 1) what are the characteristics of readily-available United States Geological Survey (USGS) landuse data and 2) how are urban landuse categories related to particular building morphological characteristics. In the first part of this paper, we compare the USGS land use data to newer, more detailed landuse datasets collected in the Los Angeles and Phoenix metropolitan areas. In the latter half of this paper, we show how the urban landuse categories correlate to building morphology for the Los Angeles area.

2. DISCUSSION

2.1 Landuse

The USGS landuse data is free, available online, and covers the entire U.S. at 200 m resolution, hence it is a valuable resource to mesoscale modelers. It follows the Anderson et al. (1976) Level 2 landuse classification scheme. However, the bulk of the data was derived from analysis of satellite images dating from the 1970's and only 7 urban landuse categories were characterized, with several being ambiguous (see Table 1). We will use newer, higher resolution landuse datasets gathered for Los Angeles (Southern California Association of Governments) and for Phoenix (Arizona State University) to better characterize the USGS urban landuse data.

Phoenix is a rapidly growing city and Fig. 1 shows the difference in areal extent of urban coverage over the 25 year period since the USGS data was obtained. Smaller discrepancies were found for Los Angeles, although specific areas revealed significant differences.

We are also determining the fractional make-up of the 7 USGS landuse categories in terms of the corresponding 108 Los Angeles and 18 Phoenix urban landuse categories in order to better characterize the somewhat ambiguous USGS urban landuse types. Figure 2 shows an example of the breakdown of USGS residential landuse category for Los Angeles using the SCAG dataset. Knowing the percentages of high density vs. low density housing, for example, allows us to better assign the appropriate building plan area density for these grid cells in a mesoscale model.

Table 1. Urban Landuse Categories

dataset source	landuse types
USGS (Anderson Level II)	Residential, Commercial Services, Industrial, Transportation & Communications, Industrial & Commercial, Mixed Urban, Other Urban
SCAG (Anderson Level III/IV)	Residential(17), Commercial Services(38), Industrial(16), Transportation & Communications (23), Industrial & Commerical(1), Mixed Urban(2), Other Urban(11)
ASU	Airport, Business Park, Retail Center, Educational, High & Medium Density Residential, Large & Small Lot Residential, Office, Public Facility, Warehouse, Transportation, Hotel, Industrial, Institutional, Assembly Area, Vacant, Open Space

2.2 Urban Morphology and Landuse

There has been some recent work correlating building morphological characteristics to landuse. Theurer (1999) gave estimates for height-to-width ratios, building heights, and area fraction for 7 urban landuse types for German cities. Grimmond and Oke (1999) reviewed many urban datasets in the context of determining the roughness length and displacement height for urban areas and as a consequence computed plan area densities and average building heights for 7 different North American cities. Cionco and Ellefsen (1998) manually calculated building densities, heights, orientation, roof pitch, among others, for El Paso, Sacramento, and Uppsala, Sweden for 15 urban landuse types using aerial-photography. Rati et al. (2000) describe techniques for abstracting building parameters from aerial photographs.

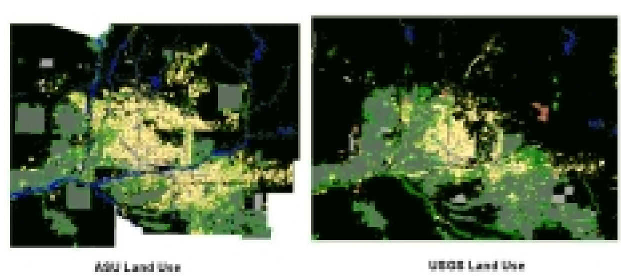

Figure 1. Comparison of the more recent ASU and the older USGS landuse for Phoenix and the surrounding area. Light areas are urban, gray are agricultural, and black are desert scrubland.

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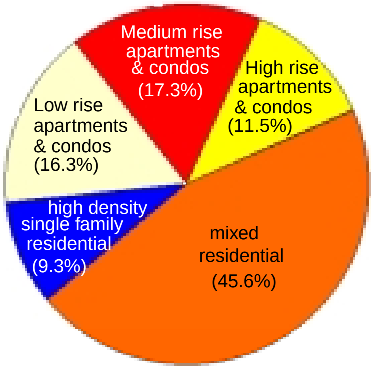

Figure 2. Breakdown of the USGS urban residential landuse type as function of SCAG urban residential sub-categories for a 12 km^2 area centered around downtown Los Angeles.

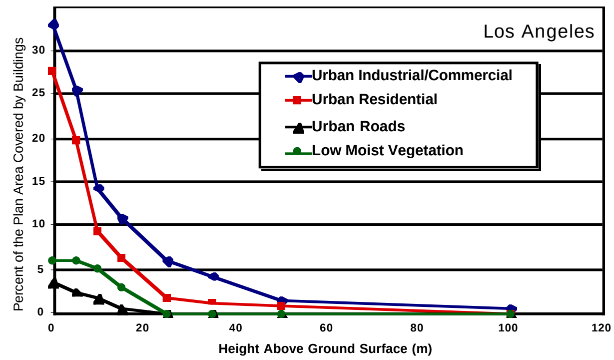

Figure 3. Building plan area fraction as a function of height for a 12 km^2 area centered around downtown Los Angeles.

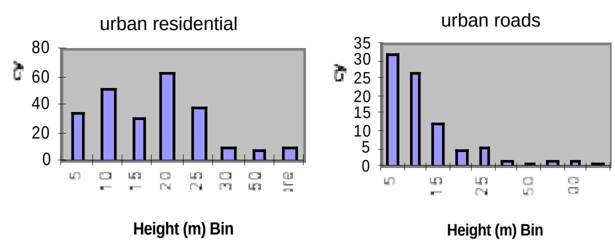

Figure 4. Building height frequency distribution for USGS urban residential and roads for a 12 km^2 area centered around downtown Los Angeles.

We have used a 3-d building dataset for a small area of downtown Los Angeles and correlated different building parameters with landuse type. Figure 3 shows building plan area fraction as a function of height for four different urban landuse types. This sort of information is needed for the radiation balance and drag terms in the mesoscale surface energy budget and momentum equations, respectively. The building height frequency plots in Fig. 4 reveal taller buildings as compared to residential areas in Vancouver (Voogt and Oke, 1997). Interestingly, the data also show significant building structures in the USGS urban roads landuse type. In the near future, we hope to perform similar studies for Salt Lake City.

3. CONCLUSIONS

Although far from being a complete survey, this study does suggest that USGS landuse data needs to be used with caution in mesoscale models. For example, urban areas may be underestimated in size and therefore their influence on mesoscale weather underpredicted. Correlation of the USGS urban landuse with building morphology is valuable in order to better prescribe the input parameters for urban canopy schemes. We hope to obtain 3-d building datasets for other cities and to develop more automated ways of deriving the data. This study represents ongoing work to better understand transport and dispersion within cities and the interaction of mesoscale and urban scale flow dynamics.

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